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PROCEEDINGS OF THE PHILADELPHIA FOUNDRYMEN'S ASSOCIATION.

The sixty-fourth meeting of the Foundrymen's Association was held at the Manufacturers' Club in Philadelphia, on Wednesday, January 6th. The chair was occupied by President P. D. Wanner.

Reading of the minutes having been dispensed with, the report from the executive committee was called for, and Secretary Evans accordingly presented the following report:

"Your committee find that the foundry business is not in a very prosperous condition. Shops are not by any means full of work, and prices are ridiculously low. As a matter of fact, prices in Philadelphia are lower than in any other city in the Union. Car wheel castings are being made for less than one cent per pound, and agricultural and general castings at prices below two cents per pound, viz., 1½ cents to 1¾ cents. During the past week a contract has been let for the castings required by the City of Philadelphia for its water and other departments, at a price less than 1½ cents per pound. The contract last year was awarded to D. S. Cresswell at $1.65 per 100 pounds. The contract for

1897 was awarded to W. S. Rhodes & Co., of Philadelphia. This fact would seem to prove that prices were not on the mend, but that the downward tendency still continues. It would appear that foundrymen are not making much effort to obtain higher prices. Foundrymen who expected an era of better prices after the election of Mr. McKinley are holding aloof from low priced business in the expectation of better prices than those existing. These hopeful ones are entirely content to let those who will, fill up their shops on low priced work, looking upon such a course as one which will remove a lot of competition from the market, and make a good opening for the boom which will certainly come. The question has arisen as to the necessity for a new credit system. It seems that certain people are buying castings at prices satisfactory enough, and when their limit of credit is reached are withdrawing their patterns and opening new accounts with other founders. The association is alive to the fact that this is a most reprehensible proceeding. It is worth while to consider a plan in regard to credits successfully adopted by a sister organization. All defaulters in that line are reported to the secretary of the association, and when the defaulter applies to a house for a line of credit, notice of such application is given the secretary, and if non-payment of bills is recorded against the applicant, the secretary notifies the member of such fact, thus preventing the opening of what would probably turn out to be a bad account."

Mr. Glover—There was another recommendation made by the executive committee that this association establish a fund. We have about $1,400 in hand, and it is suggested that we invest about $1,000 of this amount.

Mr. Schumann—That is a matter which should come up under the head of new business.

Reports from the various sections of the Price Committee were next called for, but the only report submitted was made by P. D. Wanner, chairman of the cast iron gas and water pipe section, who said: "There is little to report. The trade is in very bad shape and prices are lower than ever."

Mr. Evans—I suppose Mr. Wanner feels a little delicate about making a report. In looking over a recent number of a government organ, I notice a contract was lately taken for no less than 25,000 tons of pipe to be delivered on the streets of Baltimore at $17.30 per ton of 2,240 pounds. Now I will leave it to you to decide as to the amount of profit likely to be made on that contract. There were a number of bidders, and the firm taking the contract were the lowest bidders. I think the figure I have mentioned was the right one, if not I should like to be corrected.

Mr. Wanner—It was $19.40, which would make the figure Mr. Evans mentions correct for the net ton. I might also state that R. D. Wood & Co. took a contract for pipe, delivery at Middletown, at $18.60 per gross ton. The next lowest bidder was nearly $1 above that. There was about 2,000 tons named in the contract.

Mr. Evans—The contract I mentioned was taken by the National Pipe & Foundry Co., Scottdale, Pa. These people have been in business a number of years, and are backed by a strong element. It is to be hoped that this will be the lowest price limit.

Under the head of new business Asa W. Whitney read the following paper on "The Transverse Strength of Chilled Iron as Affected by the Relative Directions of Stress and Chill."

In presenting a novel feature of chilled iron, it would of course be more thorough to show how it was known that the complications of the subject had been taken into account to prove such a summary of tests as that given below valuable, as really measuring to an approximate degree, heretofore unnoticed phenomena. But time not permitting this detail, it must suffice to state that though my report deals with but a small number of test bars, none of which were analyzed, I know that they are practically of the same general class of material—cast iron suitable for good car wheels; and from long experience with chemical and physical tests of cast iron, and particularly from the calculated chemical composition of the cupola charge in the case of series one, I am certain that even the considerable differences shown between the two series (one and two) do not amount to a difference in kind of

metal, but merely to degree in quality of the same kind of metal. The wide difference here shown in strength and resilience between duplicates or similar bars of chilled iron, broken in one case by a stress at right angles to lines of chill, and in the other by a stress in same direction as lines of chill, is therefore mainly, if not wholly, due to the relative directions of stress and chill. As a matter of fact, the same phenomenon is more or less observable in cast iron suitable for purposes other than chilled castings. It will therefore be more accurate to understand the word "chill" in the caption of this paper as meaning "the direction of the most rapid dissipation of heat." The physical effect depending upon the composition as well as upon the rapidity of the dissipation, the result is not always solid white iron.

It is to be hoped that the presentation of these facts will lead some who may have previously noted them to report their tests, as the matter has a bearing upon the selection of proper forms and sizes of test bars.

The transverse strength is represented in this table by Modulus of Rupture, as by that means bars of different dimensions can best be compared. For any bar of rectangular cross section the formula is $3\text{-}2xWl\text{-}bd^2$ equals Modulus of Rupture. Here W is stress; l, length; b, breadth, and d, depth of test bar. By dividing the modulus in each case by 18 (the factor for a one-inch square bar 1 foot long) the strength of such bar is shown, assuming, of course, the same grain and density as that from which the modulus was calculated. Note how reasonably close the agreement is in spite of the variations in dimensions of the measured and tested bars. In less homogeneous metal, and particularly in gray iron, the agreement is less close.

Some of these bars were "rumbled" to see whether in such hard white castings any change in strength would result. In one former case where the conditions were not well known, the rumbling apparently caused a large gain in strength. Mr. Outerbridge, of Wm. Sellers & Co., has demonstrated the gain made by rumbling in the strength of gray iron bars, and my few experiments agree with his in general. But this uniform white iron is

little affected if at all. It is also the fact that certain strong very homogeneous gray compositions gain less in rumbling than ordinary mixtures similarly cast.

Another point of interest is the fact that it is proven possible to cast a high chilling iron in such form as to have nearly or quite the same modulus of rupture, whether cast in sand, so as to be just totally gray, or cast of the same volume between "chills" or iron sides of mold, giving a test bar of a less depth so as to be totally white. Compare bars No. 3 (series 1), and No. 3 Hexagon. This agrees with our regular tests of wheel metal since the writer devised a proper cross section and method of casting test bars for hard iron.

In March, 1891, daily tests of the transverse strength of the chilled wheel metal were adopted. The bars were cast 2 inches square by 15 inches long, and were chilled on the four sides. They therefore presented the same appearance in the cross-section as the small ingots 1 inch square by 4 inches long, devised by Mr. Outerbridge, and illustrated by him in an abstract of his lecture on pig iron at the Franklin Institute, February 6th, 1888.

That is, the meeting of the crystals or lines of chill form a more or less distinct pair of diagonals. The transverse tests of the large bars, as shown by the steady stress of the testing machine, was nearly as erratic as had been the tests of the small ingots by hammer blows, and were of use only in connection with the gray bar tests of same metal.

In high chilling iron particularly the square bar of four square inches sectional area cast in sand was found very unreliable as an aid to the development of my chemical method of iron mixing. Therefore in January, 1895, I obviated the trouble with hard corners by making them more obtuse, and adopted a hexagon cross-section of four square inches area. This gives a side of 1.24 inches width to rest on knife edges. This bar is very satisfactory for a great range of metal, and a large amount of study and tabulation has been based upon it. I was thus encouraged to make the chilled bar more reliable, and by March, 1895, after several experiments, devised the present very satisfactory form, the results of which are worth tabulating along with those of the

Tests of Transverse Strength of Chilled Wheel Iron. Effects of Direction of Chill. Summary Series I and II.

I—A. Whitney & Son's wheel iron. II—another founder's wheel iron.

Comparisons referred to modulus of rupture or relative transverse strength. Strong + Stress → Weak.	Series.	Number of tests.	Special marks.	Kind of bar. Cross Section.	Chill tests.	Contraction in 12 inches.	Modulus of rupture or relative transverse strength.	Net for 1-inch square bar.	Resilience. Inch pounds per pound of metal.	Remarks: R = rumbled. h = heavily. I = lightly.
				Inches. d. b.	Inch.	Inch.				
Maximum results in the strong position....	I.	4	No. 3	1¼ x 2⅜	¾	0.22	53,100	2,950	60.1	Not R.
	II.	5	c	1⅛ x 1½	5/8	0.23	50,010	2,779	46.8	Not R.
Minimum results in the strong position....	I.	4	No. 2	1¼ x 2⅜	1	0.21	47,700	2,650	49.1	Not R.
	II.	5	h	1½ x 2⅜	⅞	0.24	45,050	2,503	49.9	
Maximum results in the weak position.....	I.	2	b	1⅛ x 1¼	¾	0.23	33,025	1,835	23.4	Not R.
	II.	3	b	1½ x 1½	5/8	0.25	26,665	1,482	15.0	R. 3 hours h.
Minimum results in the weak position.....	I.	2	bx	1¼ x 1¼	¾	0.24	26,408	1,467	14.0	R. 2 hours h.
	II.	3	c	1⅛ x 1½	5/8	0.22	23,935	1,330	14.1	Not R.
Average results in the strong position..	I.	4	A. Ax Nos. 2 & 3	1¼ x 1¼ / 1½ x 2⅜	0.94	0.22	50,486	2,802	51.5	Not R.
	II.	4	A B C H	1⅛ x 1½ / 1½ x 2⅜	0.63	0.24	47,554	2,642	44.6	C. & H. Not R.
*Includes one softer bar, not completely chilled, of a mixture for lighter wheels..	I and II.	*9	5 / 4	square, / rectangular.	0.63	0.23	48,112	2,673	47.1	

CONTINUED BELOW.

Average results in the weak position	I.	2	b, bx	1¼ x 1¼	0.75	0.24	29,717	1,651	18.7	See above.
	II.	3	a b c	1¼ x 1¼	0.58	0 23	25,422	1,412	15.2	a R. ½ hr. l. b. R. 3 hrs. h. c. Not R.
	I and II.	5	a b c	1¼ x 1¼	0.65	0.23	27,140	1,506	16.6	See above.
The average results in the weak position being taken as 100, theaverage results in strong position show a difference by percentage of ▬ or —.	I				Per Cent. ▬25.3	Per Cent. —7.	Per Cent. ▬69.7		Per Cent. ▬175.4	It is evident that the rumbling has little or no effect on this solid white iron.
	II.				▬ 8.3	—4.4	▬87.1		▬193.5	
	I and II.				— 3.8	—2.6	▬77.3		—183.8	
				Hex.						
Compare the same iron as No. 3 in Series I cast in sand in hexagon form 4-inch area section same as No. 3 chilled bar. (Totally gray.)	No. 3 hexagon bar. Gray.	1	Hex No. 3	Side. 1.2408	Inch. ¾	Inch. 0.15	53,280	2,960	104.2	Not R.
3-28-'95 A. W. & Son's wheel iron cast approximately 1 inch square, but measured.	Strong position.	1	1 in. sq.	+	1	.....	46,836	2,603	28.2	Not R.
	Weak position.	1	1 in. sq.	+	....	.....	24,085	1,338	7.3	Not R.
The average results of Series II being taken as 100, the average results of Series I show a difference by percentage of ▬ or —.	Strong.	4 to 4	See Above.	Same as above.	Per Cent. ▬49.9	Per Cent. —8.4	Per Cent. ▬ 6.06		Per Cent. ▬ 15.5	Gen. Ave. 18.2 per cent. in favor of Series I. All are Heavy Wheel Mixtures. Bars totall white.
	Weak.	3 to 2			▬29.3	—4.0	▬16.9		▬ 23.0	

In the case of Series I the chemical composition of the chpola charge was known.

In the case of Series II the physical characters of the irons in charge were known.

In the case of Series I the physical characters of the preceding day's test bars were accurately known and the same compared with daily tests for many years. By occasional analysts of test bars and some tabulations and experience the daily small variations are translated into chemical changes which are to be applied by slight frequent adjustments to the charge by calculation from analysis of the material at hand. A greater range of material and more changes in the construction of the charge are allowable than in cases of Series II made in the old way.

hexagon gray bar of same metal. By keeping the same area of cross section as before (four square inches), but obtained by the depth 1½" and width 2⅔" (2.67"), a solid white bar results even with comparatively low chilling iron. The wide sides of this bar only being cast against a chiller, while the edges or narrow sides are in contact with sand, the lines or crystals of chill form straight parallel lines, and meet end to end from opposite sides, and the meeting line being at the neutral axis of the test bar, a slight flaw or incompleteness of chill there only slightly affects the strength. No change was made in the form of chill tests, which are 2½"x1½"x6"—the narrow edge, 1½"x6", being exposed to the iron chiller. The fracture of these probably shows a slightly higher chill than the same iron cast in the slightly different form of chill tests referred to in series 2.

Contraction is measured from small lugs cast on a corner of hexagon gray bar, and on the narrow side of the rectangular chilled bar. The outer faces of these lugs are smooth, as they are cast against a cast iron yoke protected otherwise by sand from the heat of the metal.

The 1½" square bars were cast in same molds as the regular flat chilled bars, but from a 1½" square pattern, in order to show the difference in strength of the two positions merely by comparison of the breaking stress. For rough comparison this does very well; as when strained across the chill they break at 4,000 to 6,000 pounds, while duplicates broken by a stress in the direction of chill crystals require 9,000 to 11,000 pounds. If the regular flat bar were broken by placing it edgeways it would not stand over 16,000 pounds even in the case of a metal like No. 3, which broken flat in the strong position of chill required 17,700 pounds. If the strength were the same in the other direction 30,100 pounds would be required to break it. Our testing machine not conveniently taking bars of this depth (2⅔"), the small square bars were more convenient.

Some rather imperfect tests of the crushing strength of such chilled iron show 150,000 to over 200,000 pounds per square inch in what I presume is the weak way. I know of no tests made on the ends of the crystals such as the position of load on tread of a

wheel. I believe it is much over 200,000 pounds, probably 300,000 pounds, at least per square inch.

Tensile strength tests in the weak way agree with a rough calculation from the transverse strength in the weak way, being 13,000 to 18,000 pounds per square inch. In the strong way the tensile strength is probably not less than 25,000 pounds.

Note the value of watching the resilience to compare irons of the same strength for a steady load.

The comparison of the two series of tests, 1 and 2, as given below, is probably about as favorable as can be made for the best modern practice in the old way of making and controlling iron mixtures. Series 2 may be taken also as representing a quality of metal about equivalent to that attained at A. Whitney & Sons' before the adoption of the above mentioned chemical system.

Series 1 represents about an average specimen of A. Whitney & Sons' wheel mixture. Its physical characters were attained by properly calculating the ultimate chemical compositions for cupola charges, and maintained without regular analyses of the casting by translating the small daily variations in physical test pieces and castings into chemical equivalents, indicating the chemical change to be made on the charge. Thus, in spite of the usual cupola return of scrap and other adverse conditions, the charges are regulated to produce practically equivalent castings. Series 1 was cast of same metal as our regular test bars of March 19th, 1896, with no thought of comparison with another founder's metal, but merely to experiment further on the relations of chill and stress. These bars were not broken until August 20th, 1896; and though the strength was not above the average, it then occurred to the writer to ask another wheelmaker, expert in the old way of regulating mixtures, to contribute to the experiment. The object was to prove the same phenomena in metal cast in the same manner, in same molds, under other conditions of mixture and cupola practice, but well within the range of good wheel metal. The request was kindly granted, the results appearing as Series 2. The results of Series 1 were examined by maker of Series 2 after his bars were cast, but before they were shipped to the writer. They were cast about September 20th, 1896,

packed in saw-dust to prevent any "rumbling" or "molecular annealing" effect in transit and broken by the writer in October, 1896, on the same machine and in the same manner as employed in case of Series 1.

Of course an accurate comparison of the relative merits of the old and new way of making up cast iron mixtures can only be made by taking other tests and expense into account for a year or more. That comparison has, however, been made at our works, and shows for itself on our records with an enormous balance both physically and economically in favor of the new way.

Mr. Whitney showed samples of the different bars referred to in his paper. The paper was listened to with great interest by those present, but no discussion took place, the ideas presented in the paper being more than ordinarily interesting and calling for close attention. Discussion was therefore deferred.

Mr. Schumann—The paper of Mr. Whitney is of great value. It throws light upon a subject in the foundry business such as we have never had before. I hope the table and matter will be printed as fully as possible. We can hardly realize the value contained in it. This much I gather, that the ideas are entirely new, and will open up a view toward progress in our business, which will be very material indeed. Had I had the information Mr. Whitney has conveyed to-night, my paper presented at the recent meeting of the Society of Mechanical Engineers would have been far more valuable and exhaustive than it was. I searched all the foreign publications and found no data like what Mr. Whitney has given us. You can realize, therefore, how valuable such information is. With it I could have extended my paper considerably. A trouble with founders is the variable contraction of castings. For instance, in making car wheels the trouble makers have experienced when the chilling was a little in excess of what it should be, and car wheels in consequence were not satisfactory. The information before us requires careful study, and we may at first think it has no bearing on general castings. But no doubt much of value will accrue from it, as it will lead to direct application of the ideas evolved.

The secretary announced as a subject for discussion the question, "What should be the temperature of core ovens to give the best results?"

Mr. Glover—Whether a fast or slow-drying oven is best would be the same thing.

Mr. Rogers—The most satisfactory ovens I ever had experience with were at the plant of Wm. Sellers & Co. I never gave the subject of degrees of heat much attention, and am not prepared to say what would be the proper amount of heat to use. I never had any disappointment with those ovens. They were very quick drying. A mold would take about two days to dry sufficiently as against four or five days with other ovens. They were fired at one end and the heat passed off through flues underneath the floor. The heat was nearly equal at bottom and top.

Mr. Schumann—The heat required must be less than 700 degrees, because that heat would make the flask very nearly a cherry red. The temperature of a core oven, as nearly as I can recollect, should be about 500 degrees. It is also necessary to change the air quickly to get rid of the moisture. In other countries I believe gas is used in the ovens instead of coke fires, the advantage claimed being that the whole oven is of the same temperature, removing the moisture more readily. The core oven of to-day is much about the same as used 50 years ago, but more care is taken in the distribution of the heat, which is generally made through ducts in the floor; and in the construction of the ovens so that the temperature is even throughout.

Mr. Ellicott—It has been my experience that when a loam or dry sand mold is placed in an oven and dried slowly, it was impossible to produce heat and steam at the same time. If on the second day the fire is brought up so that there is a temperature of 400 or 500 degrees in the oven, a much more satisfactory mold is the result.

Mr. Schumann—It goes without saying that care must be used in the degree of drying the mold. When you have a loam core and heat is applied too quickly you know the result. No

one knows it better than the statuary molders. They are frightened to death at anything like a rapid oven, for no other reason than that the gradual contraction or dissipation of the moisture should be so slow that there would be no danger of shrink cracks.

Mr. Wanner—We have a great many core ovens in our foundries, and have improved them very much of late years. We have done it by regulating the fires, depth of furnaces, chambers, and positions of drafts. It seems to me when we look back 20 to 25 years there was not much care exercised in the construction of core ovens—no chimneys at all, and the fires just anywhere. We should not be in it to-day on this plan. We have a blower for some of our fires. Others are dependent upon natural draft. I believe in a pretty low furnace wherever one can be placed; and a good chimney is a good thing always.

Mr. Schumann—We have heard mention made of core ovens where the same method of drying as is used in laundries is applied. A cylinder filled with small tubes, and between the cylinder and the tubes steam space; then a fan to drive the air through these small tubes, heated to perhaps 250 degrees. That air is passed into the space wherein the molds are placed, and thence it passes off at outlet points near the floor. I cannot speak as to their efficiency, but believe they are used in both the United States and Europe.

Mr. Messick—We tried that method, and it was not a success. We could not get a sufficiently high heat. My recollection is that with a large mold you want a high heat to penetrate the mold. Water will evaporate at 212 degrees in the atmosphere. That water must be drawn out from the inside, and the heat cannot be maintained with steam. I would not advise anyone to attempt to heat with steam.

Mr. Ellicott—We once tried to dry with hot air, but it only produced a heavy sweat through the mold.

Mr. Messick—If you do not get heat enough to draw the moisture out of the mold all the blast in the world will not help you. It might work on thin cores.

Mr. Evans—At the last meeting of the Western Foundrymen's Association some discussion took place in regard to core ovens, and I noticed the average heat was 390 degrees. In the upper part of the oven the temperature, I think, was 340 degrees, and in the lower 440 degrees, making an average of about 390 degrees.

Mr. Glover—Some years ago we used to make a good many radiators, and we had trouble in drying the molds properly. With too much heat they burned. We had a large japanning oven heated with steam, and we tried it for a long time. The best heat we could get was 270 degrees, but the molds would never dry thoroughly, and we gave it up. I think about 350 to 400 degrees would be a safe temperature.

Secretary Evans then asked for suggestions as to the investment of $1,000 of the association's funds, but on motion of Mr. Wanner, the matter was referred to the executive committee with power to act.

Secretary Evans—We have this question asked of us, "What is understood by gun metal iron?"

Mr. Whitney—I understand it to be such metal as would be used in making gun carriages or guns—I have not analyzed any. The tensile strength specified, I think, is about 28,000 pounds. It has been decided that gun metal should be cast from a furnace and not from a cupola; yet metal cast from a cupola was recently passed as satisfactory.

Mr. Glover—Guns are being made in a South Boston foundry, and the standard has been raised from 28,000 to 33,000 pounds tensile strength.

Mr. Ellicott—A firm having a government contract made some castings of the strength required, but made them from the cupola. Some trouble arose on this point. Now an elongation of 2-10 of 1 per cent was also required, the object being to prevent the use of steel in the castings.

The meeting then adjourned.

PROCEEDINGS OF THE WESTERN FOUNDRYMEN'S ASSOCIATION.

The regular monthly meeting of the Western Foundrymen's Association was held Wednesday evening, January 20, 1897, at the Great Northern Hotel, Chicago. In the absence of the president, the vice-president, Mr. William Ferguson, called the meeting to order.

By request of the chairman, Mr. Carver addressed the meeting as follows:

I am one of the new members, but I never belonged to any association in which I have taken so much pleasure and from which I have derived so much benefit as I have from the Western Foundrymen's Association. In talking with the different members in regard to their experience in foundry practice, I have obtained a great many new ideas, and I have got a good many ideas which I have found of practical value. I think if we could only formulate some definite plan for getting all the good there is out of the association, so that we can all get the benefit of it, we would be accomplishing the ends and aims that were designed by the Association of the Western Foundrymen. We have had some good papers here. They have brought out a great deal of discussion and have done a great deal of good among the members. I think that if we will each of us take an active personal interest and submit to our secretary suitable questions for discussion, it will lead to a variety of subjects being brought forth, and those questions being submitted to the association will give us the benefit of the experience of the other fellows. I am gratified to think that I have been a member of this association for the past year, and I believe that if proper steps are taken to present the association to foundrymen in Chicago and in the west in the proper light, that all of them will become active members, and if they can be prevailed upon to give it a little personal attention, we will derive a great deal of benefit.

Mr. Pettigrew—There is no doubt that it is a benefit to be connected with an association of this kind. I remember a good

many years ago when we were molding the castings for a large steamship in the city of Glasgow, the foremen of the shops all joined together to get one another's views. I think by coming together and having regular topical subjects to discuss, we will derive a great deal of benefit. I must say that the foundries that I have been connected with are not much further advanced than when I was an apprentice. I think that we can get a great deal of good out of each other.

Mr. Ferguson—I do not agree with Mr. Pettigrew; I believe that there has been a steady advance in the foundry. It is noticeable to me since I was an apprentice at the trade. We can all refer to specially good molders in earlier days, but I believe that there was not as much required of molders in days gone by as there is at the present time. We have advanced and have kept pretty good pace with the times. The one thing that to my mind is chargeable for lack of advancement, is the lack of proper education among the men to make them mechanics.

Mr. Pettigrew—Now you are getting into talkable subjects. In my young days a molder had to serve seven years, and I claim they cannot make a molder in four years. And another thing, almost all molders that I have met here cannot go much farther than the rule of three. In my young days you could not find one molder in a hundred who could not do any problem in algebra. We have not the education among the molders that we had among the molders in Glasgow.

Mr. Moore—What the association needs is some one else to speak; that is, others to speak. I have attended these meetings since the organization of the association, and believe that one of the greatest needs of the association is general discussion and a disposition on the part of all who attend to take part in the discussions, to dip in their oars, to show a willingness to impart as well as receive information. This is one great need. We are perhaps short of practical men who have ability as speakers, but we should all do what we can, and when any one has any idea, let him give it out for what it is worth and tell what he knows. There are members who could prepare papers on special sub-

jects, but so far they have not done so. I think we can congratulate ourselves on the way that this association, which was begun about three years ago, has grown and prospered. It has done better each year than the year before, and as an association it has undoubtedly been more prosperous than some of the members individually; it has had more money in the treasury at the end of each year than it has had the previous year, and I think that though it has grown stronger each year it yet fails to fill the purpose which we would like to have it fill. All that is necessary is for each one to chip in and do what he can, and above all he must speak up. If each one will come here, and each one say what he can on the subject of steel or iron, we will get a fund of information which will be of inestimable value to the association and to its members. That is what we want, good attendance and talk. I do not know of anything more important than that.

Mr. Sercomb—It is true I am one of the charter members of the association, and I also had the honor to be the presiding officer pro tem. of the organization. Although I have not attended many meetings lately, my interest in the association has not waned. Times have not been of the best, and my time has been taken up very much at home. I think that is about to be removed and the dawn of a better day coming. The material men are a part of this association; they come here to put themselves in touch with the foundrymen. This is a foundrymen's association it is true, and I feel that the active foundrymen should be at the head, but the material men should have a voice in the meetings. I have taken full interest in the association. I know that it is a benefit to me to come to the meetings and get the experience and knowledge of the men we have here to-night. I think that what we need is full interest taken on the part of the different members, and when we take an interest we will get good papers. We will do a powerful good for the benefit of the iron men and the material men, and every other man who is connected with the iron trade.

Mr. Sercomb called attention to some amendments to the by-laws, which had been proposed by one of the members. After

some discussion, participated in by Messrs. Moore and Sorge, it was decided to postpone further action upon this subject until later, when more time could be had for a thorough debate as to the merits of the proposed changes.

Mr. Vrooman—There is, down deep in the heart of every foundryman in this city, a feeling that there must be something else than mere discussion. There must be a financial benefit attached to this association to draw to it the members from whom you expect to draw your support. I believe we should establish a credit system to draw the foundrymen to us. There is not a foundryman in this city who would not gladly pay $100 if he knew that he was going to be benefited in a financial way. He wants something more than mere dry education. He is looking for dollars, and this association can take up such a credit system, and I am sure that there is no foundryman in this city who would not give $100 a year if he knew that he could be protected from the people who get castings everywhere and never pay for them. I care not where I stand as to the associate and active members, but I wish to say that which I think will be of the most good to the foundry business. As it was said here, it had been said that this was a supply man's association. The paper that was placed before the association on the question of classification I thought a good thing at the time, but to-day I believe that we were not in a position to classify the members; that the members of this association paying the like amount should receive the like benefit, and right to have a voice in the proceedings, and I think that the amendments as set forth will be a benefit not only to the association, but to the foundrymen in Chicago.

Mr. Sorge—Mr. Carver stated that steps should be taken for increasing membership. I confess that I have been trying to take steps, but have not actually taken them for the simple reason that I do not know how. They are simply so many questions. I would suggest that the members make it a point that if any special occurrence is observed by them that they write of it to the association. It is the best information that we can possibly get.

PROCEEDINGS OF THE PITTSBURG FOUNDRYMEN'S ASSOCIATION.

The January meeting of the Pittsburg Foundrymen's Association was held at its rooms in the Builders' Exchange, Monday evening, January 25, with President Robert Taylor in the chair.

Pursuant to action taken at the last meeting, the order of the evening was stated to be discussion of the paper read by Mr. A. B. Harrison, of the Clinton Iron & Steel Co., at the December meeting on "Freaks in Foundry Iron." The secretary read communications on the subject, received by the association and by Mr. Harrison from A. E. Outerbridge, Jr., of Philadelphia, and Thos. D. West, of Sharpsville, Pa. In his letter to Secretary Zimmers, Mr. Outerbridge referred to his paper at the Pittsburg meeting of the American Institute of Mining Engineers in February, 1896, on "The Mobility of Molecules of Cast Iron," and expressed gratification at Mr. Harrison's confirmation of the results of his experiments detailed therein. The minimum gain in transverse strength shown by Mr. Harrison for tumbled bars was 6.62 per cent and the maximum gain 44.68 per cent, or much more than Mr. Outerbridge had claimed. The irregular results in tensile tests, as given by Mr. Harrison—the maximum increase amounting to 34.41 per cent, while in other tests there was an apparent decrease in strength, the maximum decrease being 16.66 per cent—were also spoken of in the letter, and Mr. Outerbridge referred to his published explanation of irregularities that might be expected where rough bars were pulled.

Additional comment by Mr. Outerbridge, contained in a letter to Mr. Harrison, was also read by the secretary: "If you pour two sets of bars from one ladle of iron, one hot and the other dull, the cold-poured bars will be much weaker than the other; but if you then repeat the experiment and 'tumble' the dull-poured bars, the gain in strength more than offsets the loss in strength by cold-pouring. You may drill a hole 1-4 or 3-16 inch diameter through the middle of a bar which has been rumbled, or across the section at a point of rupture, and this bar will still

be stronger, even if not rumbled, by having such a hole drilled across it. I attribute this curious fact to a release of internal strain caused by removing the metal from the center of the bar."

In line with what Mr. Outerbridge had written, as to the relative strength of hot-poured and dull-poured bars and the effect of tumbling, the secretary read a memorandum of results attained in later experiments by Mr. Harrison. The mixture was 60 per cent pig iron and 40 per cent scrap. The bars were cast in pairs. The results as to strength were as follows:

a, hot-poured	tensile strength	21,772	lbs.
b, dull-poured	" "	19,544	"
a^1, hot-poured bars tumbled	" "	23,873	"
b^1, dull-poured bars tumbled	" "	24,764	"

The cold-poured bars b gave a decrease of 10.23 per cent from the hot-poured, but after tumbling gave over hot-poured bars tumbled a^1, an increase of 3.59 per cent. The increase of strength from tumbling cold-poured bars (b^1 over b) was 26.78 per cent. The increase of strength in hot-poured bars, due to tumbling was 9.65 per cent (a^1 over a). The increase of tumbled cold-poured bars over hot-poured bars not tumbled (b^1 over a) was 13.28 per cent.

Mr. West's letter contribution to the discussion expressed regret that some one size of a round bar cast on end had not been used, and that size of not less than one square inch area. Mr. Harrison's experience that the strongest records in testing were secured from bars tested with the "drag" side up was just the reverse of Mr. West's, the latter having first called attention to the difference in results from applying the load on the "cope" and "drag" side of bars. The fact that tumbling had been found by Mr. Harrison to remove the difference in strength which had existed between "drag" side and "cope" side testing, Mr. West considered very important as affording an explanation of certain phenomena in connection with cast iron. The plan of testing the fluidity of metal, as explained by Mr. Harrison, Mr. West had not found satisfactory, and he referred to the method

he had advocated at the Pittsburg meeting of the American Institute of Mining Engineers, of connecting fluidity strips with vertically poured test bars, as giving more accurate results. In conclusion he observed that the sooner the foundry world discarded bars below one square inch area and cast flat, the sooner would freaks in cast iron disappear.

Mr. Frank read portions of Mr. Outerbridge's Pittsburg paper of February, 1896, referred to in his letter spoken of above.

Discussion followed, participated in by nearly every member present. Remarks on the presence of sulphur in the iron diverted the line of thought to coke and various ways of lessening and detecting sulphur. The question of the deterioration of coke exposed to the elements was also discussed.

Mr. Seaman stated that with him chemical analysis had proved scarcely practicable in his large castings. The difficulty arose from the variableness of results. Heats charged with material of the same analyses had brought widely different results. Tests taken 20 minutes apart differed.

The following paper on "Regulations of Foundry Mixtures," prepared by Thos. D. West, was read by the secretary:

"It is to heavy founding that we must chiefly look for the best opportunities for obtaining knowledge of the manner in which the various metalloids affect the carbon in giving characteristic qualities and in changing the grade of iron. This arises from the simple fact that in heavy founding, castings of all grades are demanded. Then again, in order to obtain accurate information we must deal with actual practice, for physical conditions in founding can often affect the character of iron or the condition of its carbon as much as changes in its chemical composition. Tests of iron from a crucible, etc., are of little value in advancing practical knowledge and have only created confusion of methods and ideas on the effects of metalloids. This has gone to such an extent that many seekers after information upon the metallurgy of iron are more confounded than enlightened on many points.

Some advise regulating the mixture or changing the "grade" of the iron by means of alterations in the percentage of silicon;

others by changes in manganese, and again others, by changes in phosphorus. To illustrate the effects of these elements and as a demonstration of what I consider the best base for regulating mixtures, I would consider what are the constant and what the changeable metalloids, in order to discover what elements are really responsible for changes in the character of pig iron, as it comes in "brands" to the foundry yard. If, in making iron, all the metalloids remained fairly constant, not varying in the percentages, one "cast" after another, we could obtain a uniform product and have no such thing as grades of iron from like mixtures of ore, fuel and limestone. But this is not what exists. Instead of uniformity we find that a furnace cannot at the present stage of furnace advancement make two "casts" alike, and hence we find that any furnace will, from the same mixture of ore, fuel and limestone, give a wholly different "grade" or analysis of iron at almost every "cast." Now, the question simply narrows itself down to this: Are there metalloids that cannot be controlled? Are there those whose erratic action causes a diversity in results? Experience answers, "Yes," and analyses prove that silicon and sulphur are the metalloids wholly responsible for creating the difference in grades of iron, coming from similar mixtures of ore, fuel and limestone in smelting, from the fact that the total carbon, manganese and phosphorus generally remain practically the same, one "cast" after another.

When making the iron, silicon and sulphur jump around in such a lawless manner that the most radical difference may be expected in "grades" in the various "casts." A furnaceman can be most particular and have all conditions alike, so far as in his power, yet for all this no two "casts" will be exactly alike in silicon and sulphur contents. Now if it were in the power of the furnaceman to maintain the same uniformity in the silicon and sulphur that he generally secures in the case of total carbon, manganese and phosphorus, there would be no difference in the grades of iron, and all would be practically the same in physical qualities. In all that I have written on this subject, I have made silicon and sulphur the basis of calculation and have contended that as much importance should be attached to knowing the

percentage of the one as of the other. I still maintain that this position is correct and that this is the right practice to follow. In making iron, the furnaceman can control the percentage of manganese or phosphorus in his iron by his mixtures of ores, fuel and limestone to obtain practically any specialties he may want, whether of high, medium or low manganese or phosphorus iron. What little variations may occur in the percentages of these two metalloids in irons will have no practical effect on the carbon to change the "grade" or the character of the iron coming from one mixture of ores, fluxes and fuel.

It is to be remembered that I do not claim that manganese and phosphorus cannot affect the carbon or the character of iron. Either of these can change the physical qualities just as variations in the percentages of silicon or sulphur change them; but we must look to the furnaceman to do this in preparing his mixtures of ores, lime and fuels in making the iron. If any one desires an iron high, medium or low in manganese or phosphorus, he can generally get it so even in its percentages as not to affect, in a practical way, the "grade" or physical qualities of the iron which he desires to obtain, and this can generally be achieved, day in and day out, at every "cast," as long as the furnace continues to use the same ores, fuel and flux. On the other hand, silicon and sulphur will vary at every "cast," in spite of all the present furnaceman's calculations, and it is the changes in these two metalloids that we should consider as affecting the "grade" of iron, or in causing it to vary in its percentages of graphite or combined carbon. This makes evident what are the metalloids that the founder should recognize as bases for changing the "grade" of his mixtures or physical qualities obtained in the castings produced.

Although furnaces are unable to control the silicon and sulphur and make them uniform at the present day, the writer has faith that future advancement of practice in attaining more uniform temperatures steadily in a furnace will bring about a great improvement in this line; nevertheless, silicon and sulphur will always be the metalloids subject to change the "grade" of iron where the same ores, fuel and fluxes are used and be the elements

to which the founder should look for making variations in the "grade" of a furnace product, working on one brand of iron, or in making or altering mixtures for the founder in remelting iron.

The fact that silicon is important in regulating and softening mixtures was first suggested by Dr. Percy, some 35 years ago, but it awaited experiments, in 1885, by Mr. Charles Wood, a founder of Middlesbrough, assisted by John C. Stead, the expert chemist, both of England, to first practically demonstrate the value and utility of silicon as a softener and its application to founding, a work which, it should be said, had its foundation laid in experiments conducted by Prof. Thomas Turner, at Mason College, Birmingham, Eng., the same being presented a few months later at the Glasgow meeting of the Iron and Steel Institute. The extensive publication of this paper is really responsible for the universal adoption of silicon as a softener and partial regulator of mixtures in iron.

It is intimated above that the total carbon is not perceptibly altered where the same fuel, ore and limestone are used in making iron. This is to be understood as referring to iron being made under normal conditions, which insures a furnace running without having any "slips" or factors to cause an excessive cold or hot working furnace. The opinion of a few furnacemen with whom I have discussed this point is to the effect that the higher the temperature and the more slowly the ore passes down to the hearth as iron in a fluid state, the greater carbon will be found in the iron. This is to be taken only as an opinion, based on good reasoning, as I have failed to find any furnacemen that have followed these relations by exacting analyses to know positively what radical changes in the temperature of a furnace or the speed of reduction would make in the total carbon, where the same ores, fluxes and fuel are used. However, what slight changes may be made in the total carbon by normal working of a furnace can have little effect in changing the "grade" of an iron; and this leaves us to recognize the silicon and sulphur, as stated above, to be the metalloids chiefly responsible for giving us "grades" in iron from similar mixtures of ore, fluxes and fuel."

Discussion was deferred for one month and after extending a vote of thanks to Mr. West, the meeting adjourned.

GEAR MOLDING AND GEAR MOLDING MACHINES.

A Paper Read Before the National Foundrymen's Convention Held in Philadelphia, Pa., May, 1896.

By S. GROVES, M. E.*

When the philosophic historian comes to write the industrial history of the latter part of this Nineteenth Century, not the least important chapter will be the interesting story of the renaiscence of iron-founding; and when he endeavors to divine the causes which gave the momentum to this revival, he will probably point, in the first place, to the invention of the geared ladle by Nasmyth in 1838 as the first application of practical mechanics to

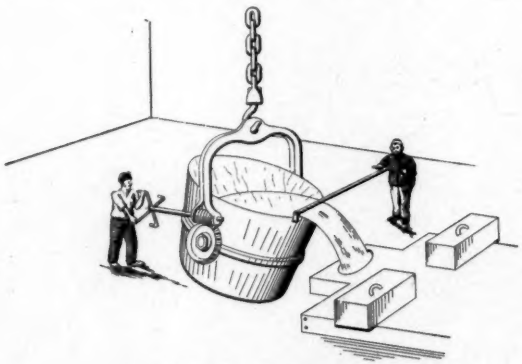

FIG. 1—NASMYTH'S LADLE.

which gave the momentum to this revival, he will probably point the economic handling of material in the foundry; and, to the invention of the first gear molding machine by Jackson in 1855 as the primary effort of the iron founder to reduce his rule of thumb and guesswork practice to the exactitude and precision of a science. For many years after the invention of these initial appliances, very little progress was made

*Delayed in publication, owing to the loss of the original manuscript.

in the adoption of labor-saving devices, and mold forming machines, for duplicate work. During the last decade, however, a marked change has come over the scene. There is as much difference between the foundries of Philadelphia to-day and the foundries of my boyhood, as there is between the miserable horse car—which is fast becoming a curiosity—and the brilliantly lighted, finely furnished and rapid running electric cars of our modern streets. Indeed, I was greatly tempted at this point to dilate upon the general subject of modern foundry appliances; but, inasmuch as the limited theme of gear molding and gear molding machines has been allotted to me, I must observe the discipline of the convention, and confine my remarks to this special branch of founding.

A year ago, it was my privilege to read before the Foundrymen's Association in this city (Philadelphia) an essay on "Machine Molding, with Special Reference to the Manufacture of Gears," in which I described with copious illustration the molding of gear wheels by machinery; contrasting this new and scientific method with the primitive custom of hand molding—by means of expensive full patterns. And since I can not report any new discoveries in this important branch of trade during the intervening twelve months, it only remains for me to supplement the generalities then stated with some particulars and practical details noted in the process of actual manufacture. It may be a startling assertion, but it is nevertheless a fact, that in no branch of the art of founding is there demanded of the molder more skill, patience, resource and intelligent perception of the laws of cause and effect than in the molding, say of a 12′ double helical, split gear, weighing some 12 tons, in which the pitch diameter and depth of face must not appreciably vary, the teeth be equidistant, and so clean that neither file nor hammer nor chisel must be used on the flanks of any one of them. And yet, with properly designed machines and experienced artisans, it is possible to approximate to this degree of perfection. I now proceed to describe the modus operandi.

Notwithstanding the manifest advantages of machine molding, it is astonishing to find how tenaciously some people cling

to the antiquated. Take, for example, the molding of a worm for

WORM GEARING.

The common method of molding a worm is, to form the mold by means of a pattern made in halves. Now, these pattern halves can not be withdrawn from the sand direct, owing to the overhang of the threads; they must be twisted out. Anyone who has tried to do it knows how difficult it is—patching and mending invariably follow. This trouble, together with the enlargement of the mold, due to rapping, added to the unsightly fin which appear on the casting at the parting of the pattern, renders this old plan altogether unsatisfactory. But the machinery molder has completely overcome these difficulties by bringing to his aid a simple mechanical appliance. A brass pattern is chased in the lathe, having the necessary allowance for contraction. This pattern, with tapered core print at lower end and tapped hole in top for receiving lifting rod, is set vertically in the flask, hand packed with suitable facing, rammed around, and strickled off. This done, a plate having hole in center of same shape and rake as thread of worm, also a cross bow with guiding gland in middle, is secured to top of flask. The lifting rod, with left-handed screw, is then inserted into the pattern, and the pattern screwed out of the mold up through the slot in cover plate, the mold of each thread being self-slecked in the process of withdrawal. The cope is then put on and the mold poured. Thus, by a simple method of machine molding, duplicate worms, perfectly smooth and true, can be cast in greatly increased quantities and at comparatively small cost.

SMALLER GEARING.

Again. Why endure the slow and costly process of cutting the teeth of smaller duplicate gears in the machine shop, when, by means of a cut toothed iron or brass pattern, fixed on a drawback mold forming machine, a laborer can make these gears almost as fast as a skilled molder can turn out the blanks! And what is more, the teeth will have the advantage of the hard skin for a wearing surface, which is removed when the teeth are cut out of blanks in a lathe.

We now come to the molding of gears of magnitude, and in dealing with this part of my subject, I may say, at the very outset, that when you know how, the molding of gears up to, say, 6′ diameter on a revolving table machine is like the machine molding of worms and small gears, a very simple process. A common laborer can soon be trained to do the work perfectly. After he has once made successfully, a spur, bevel, helical or worm wheel, the process in each subsequent case is very similar, and the man becomes practically part of the machine. When, however, we come to the machine molding of heavy wheels over 6′ diameter—which must be made in the floor, and not on a table machine for fear of injuring it as an instrument of precision—then we are confronted with an altogether different condition of things. The common laborer is no longer available; the molder must be, in every sense of the word, a mechanic. Take, for example, a double helical gear 14′ diamater, $4\frac{1}{2}''$ pitch, made in halves by means of splitting plates. In the first place, there must be heavy anchor foundations, covered with a layer of sand, then a coke bed with vent pipes for conveying off the gases generated under the mold; then another layer of hard rammed sand, upon which is built a brick wall; and a point of importance is that these bricks should be porous. The portable molding machine is then fixed, sweep adjusted, and the mold bottom properly leveled and swept. Then commences the interesting process of machine molding the teeth. A laborer operates the drawback machine and index, inside the ring, while the molder, standing outside the wall, leans over, and rams the teeth. Here comes into play the skill and resource of the experienced molder, for, in selecting his facings, several important conditions have to be observed. The fine grained sands which he used for 1″ pitch will not do for teeth $4\frac{1}{2}''$ pitch, the particles of silica in the sands must be coarser, in order to render the facing porous, and thus allow for the free exit of the gases; it must be sufficiently cohesive to mold well and resist pressure, and sufficiently refractory to prevent the burning action of the hot metal. Further, the molder, in ramming the teeth, must be able to judge exactly the necessary degree of force to impart to his rammer; the force

applied in forming the tooth spaces for 1″ pitch will not do for the larger sizes; and besides, the ramming must be uniform, since a hard spot here and a soft spot there, will tell its miserable tale when the gear is lifted out of the sand, either in unsightly scabs or ugly swellings, necessitating the use of hammer and chisel. And I may remark here that in molding the teeth of large gears of 3″ pitch and upwards, it has been found necessary to vent the mold of each tooth space, by leaving an oblong hole in

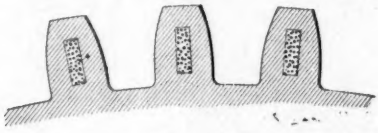

FIG. 2—MODE OF VENTING GEAR TEETH.

the middle, which is connected to the coke bed below by a vent wire and filled with fine particles of coke. Teeth molds formed in this manner afterwards coated with a refractory solution, and thoroughly skin dried, not by the erratic heat of a coal or coke fire, but by a steady, regulated gas flame delivered through small holes in a 1″ tube ring—about 12″ less in diameter than the mold—will produce teeth with sharply defined edges, and flanks bright, smooth and clean.

Another important improvement in manufacture is the substitution of green sand for dry sand arm cores. This is one more instance of necessity being the mother of invention. If a large gear is to be true in diameter, there must be no resistance to general shrinkage. The shrinkage which takes place in the arms towards the hub must be followed by the run between the arms also; anything which hinders this onward movement is detrimental to the diametral perfection of the gear. Hard-earned experience has proved that this is just what dry sand cores are found to do: hinder normal shrinkage. I well remember a deplorable instance of this. It was a large gear, 7″ pitch 30″ face, and when cast, a number of teeth were cracked transversely across the face, midway between the shrouds. The use of dry sand cores was manifestly the main cause of this mishap, for the arms were of I sec-

tion, and as the metal in the top and bottom flanges shrank in towards the hub, it naturally drew the run and whole face of the gear with it; but the hard dry sand cores resisted this, hence the metal in the teeth opened out in the middle. From that time forth I discarded dry sand cores, using only hollow, coke-filled green sand cores, made of coarse gravel or gum sand; and in no instance was the old trouble repeated, for they adjusted themselves to the shrinkage of the environing metal.

Having described the method of forming the teeth molds, selecting facings, and making the green sand arm cores, we now pass on to the question of covering in. In casting a heavy gear it is important that there should be no strain; the slightest uplift of the cope would cause the width of the face to vary and the gear to run untrue. With this danger in mind, flexible wooden copes have been entirely discarded as being liable to twist in lifting and bulge under pressure. Ponderous iron copes have also been altogether abandoned, both on the score of expense and

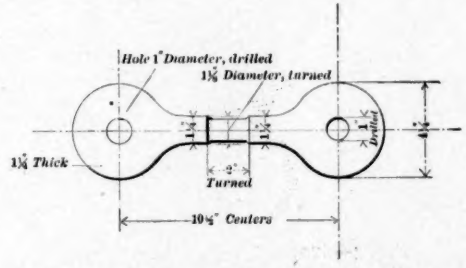

FIG. 3—FORM OF TEST BAR USED IN TESTING ENGLISH IRON.

difficulty in handling. The best makers now use strong dry sand covering cores exclusively, a system which represents a manifest advance in the art of molding large gears; it is safe, economical and expeditious.

Then there is the question of metals. If ever there was a case where test bars are a necessity, it is in the manufacture of gears, for the buyer insists upon a guarantee that the metal in the casting must stand a tensile strain of 30,000 pounds per square inch!

I may be permitted to say a word at this stage, relative to

the discussion we have just had, upon the shape and size of test bars. If I did not take part in the debate it was not because I had no experience, for it was my good fortune to be engaged some few years ago in the systematic testing of almost every brand of pig iron used in the British iron trade, and I have here a record of over 1,000 tests, both transverse and tensile, which I conducted during the four years ending 1888. The form of test bar used was as shown in Fig. 3; the middle was turned and the pin holes drilled perfectly at right angles to the center of

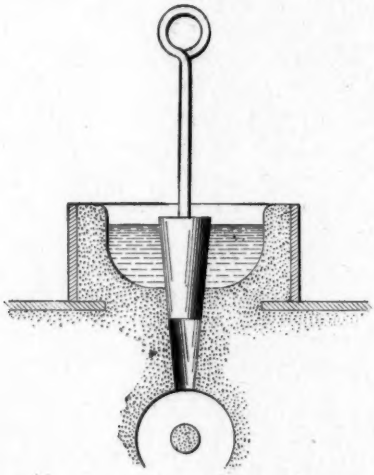

FIG. 4—STOPPER FOR POURING GATE.

the turned section, in order that the strain should be in the direct line of the applied forces.

There may be objections urged to this shape of test bar, but, in my opinion, it is greatly to be preferred to the square-ended test bars commonly used by American foundrymen, which are held in the machine between file-faced grips. After the faces of these grips become worn, slipping takes place, and I verily believe that many of the erratic records presented to us of tensile tests is due to twisting and cross straining due to this defective system of testing. The only trouble we ever had with these bars

was the congregating of blow holes in the narrow neck. This trouble was overcome, however, by ramming up the molds horizontally, but casting the bars vertically—pouring from the bottom. The pouring gate at the top (Fig. 4) was filled with the calculated quantity of metal, the plug was withdrawn and the metal rushed down the gate hole to the bottom of the flask up through the mold, carrying the confined air and gases before it, and thus insuring a clean casting.

The metal for a gear should be as close grained as possible, especially in the teeth, since a skin of fine grained combined carbon offers the best wearing surface; yet must not be chilled, as in many cases the shrouds must be turned, the hub bored and keyseated in the machine shop, hence must not be too hard for the tool. It is of vital importance, therefore, that the gear founder be capable not only of scientifically grading his facing sands to suit the varying magniture of his castings, but, for a like reason, must have an exact knowledge of the selection of metals by analysis. A metal mixture containing $2\frac{1}{2}$ to 3 per cent of silicon would be suitable for a gear of 1″ pitch, but would be useless for a large gear of 7″ pitch, in which the mixture should contain an average of about $1\frac{1}{2}$ per cent of silicon. Another condition worth noting is, that if the casting is to be sound and the teeth sharply defined, the metal poured into the mold must be hot—at a high temperature. With lively metal the gases generated in the mold can be easily expelled, and owing to its fluidity shoots quickly out of the hub, along the arms, into the run and teeth around the circle, filling every nook and corner in the mold, and producing teeth with the knife edge appearance which the gear molder who takes a pride in his work likes to see.

The only difference between the molding of large gears in the floor and smaller gears on the table machine is that in the case of the latter they are manufactured in interchangeable cast iron flasks, both cope and drag, having perforated bodies, planed joints and carefully fitted double tapered guide pins.

The lecturer then gave an interesting description of the operation of his own gear molding machine, on which a patent was then pending and has since been granted, concluding as follows:

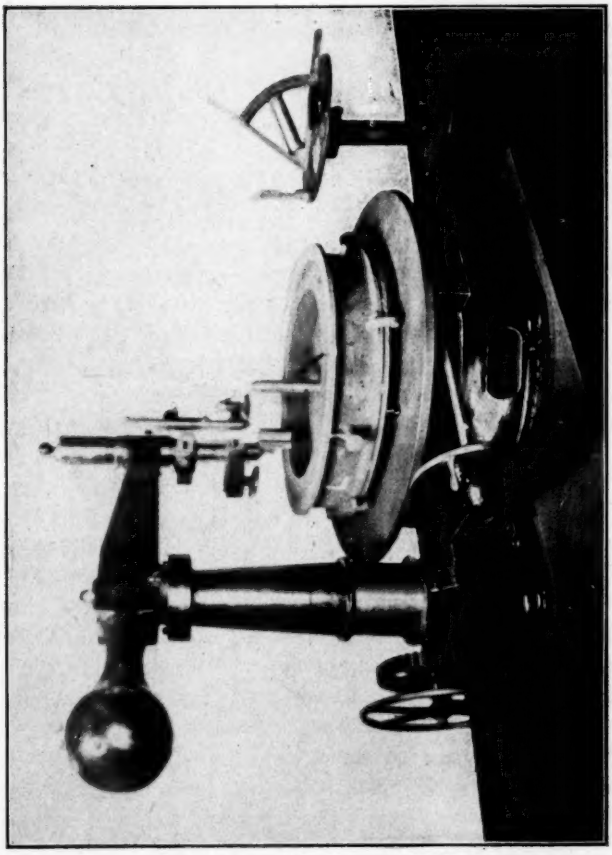

FIG. 5—GROVES' PATENT GEAR MOLDING MACHINE.

Such, gentlemen, is a brief statement of the case for the machine molding of gears. In the opinion of some here, the practical details I have just set forth may seem like giving away valuable trade secrets. My reply is that the days of selfishness and exclusiveness are passing away. This meeting of foundrymen from all parts of the United States, in the City of Brotherly Love, is the beginning of a new era in the relations between the foundrymen of America. The light is breaking over the hills. The noble spirit of generosity and good-will manifested by the leading firms of Philadelphia in unreservedly opening their works for our inspection during this convention is, indeed, one of the "signs of the times." The day of high walls and strongly barred gates is over. The electric searchlight and X Ray is here. Nothing can be hid long.

If we could all emulate the noble, self-denying spirit displayed by James Nasmyth, the inventor of the geared ladle, the onward march of progress in the art of founding would be wonderfully accelerated. Prior to his invention, the old style ladles were tilted in the act of pouring by men holding on to the handles by sheer manual strength, and frightful accidents occurred. By his device of worm and gear not only was all risk of accident removed, but the perfection of the casting was assured by the steady, continuous flow of the hot metal into the mold, while by means of the lip skimmer a clean flow of metal was secured.

He says in his autobiography—a book which every machine shop and foundry apprentice in the country should read: "I might have patented them, but preferred to make them over to the public. I sent drawings and descriptions of the safety foundry ladle to all the principal founders both at home and abroad, and I was soon after much gratified by their cordial expression of its practical value. The ladle is now universally adopted."

It can not be doubted that this device has been the means of saving the bodies and preserving the lives of numbers of workmen in the foundries of the world. Therefore, I call upon you, gentlemen, to join me in this sentiment—honor to James Nasmyth! And side by side with the name of James Nasmyth I would mention the name of one who is in our midst

this day; one whose name will be remembered in the annals of the American iron trade when most of us are forgotten; one who for years has been toiling in his laboratory—even during the midnight hours when we were asleep—conducting valuable scientific experiments with foundry irons, recording the facts and giving out the data freely in trade journal, magazine and convention, for the benefit of foundrymen—I mean our good friend and comrade, W. J. Keep, of Detroit!

With men like W. J. Keep, Thos. D. West, the pioneer of foundry literature, and others, able and willing to give freely of their ripe experience and rich knowledge of the various branches of founding, then one can safely predict a bright and prosperous future for the National Association of Foundrymen, so happily inaugurated at this convention. I thank you, gentlemen, for your attention, and if the thoughts and facts presented have contributed in any way to your pleasure and profit, I shall esteem myself amply rewarded.

A REVIEW OF THE FOUNDRY LITERATURE OF THE MONTH.

AMERICAN MACHINIST.

But a small amount of literature has appeared on the subject of steel founding. We have noted the increasing use of steel castings, but the general shop practice has not to any great extent found its way into print. In the American Machinist for January 14th, Geo. A. Vair has an illustrated article on "Molding and Gating Steel Castings," choosing for his subject a gear wheel, with which to illustrate the peculiarities of steel. We print below some abstracts of Mr. Vair's article:

* * * Comparatively few iron molders have a clear conception of the difference between iron and steel molding, and the writer herewith presents sketches which may help anyone interested in forming an idea as to the dissimilarity. * * * It must not be understood that any ordinary dry-sand mixture that is suitable for iron castings will answer the purpose for steel molds, as it will not. The material used is known as silica sand, which is found in stone form, the same being ground finely. When mixing the sand for use, flour and molasses water are added to give cohesiveness. One of the chief requirements of sand suitable for steel castings is that it will stand a high degree of heat before fusing. Of course, the above is in reference to the facing, or sand that is exposed to the flow of the metal. For backing sand, any grade will do which will bake hard. I might add that for gear teeth, or delicate projections, special sand mixtures are used.

All steel molds are also coated with a silica wash, which is applied as blackwash is on molds for iron castings. The washes for steel molds have been greatly improved in recent years. The result is that castings which formerly required days to clean now peel with the rap of a hammer.

In writng of "Chilled Castings," L. C. Jewett notes the following:

* * * Attempt has been made, in one instance at least, to pour two different mixtures—a chilling mixture for the chilled portion, and a common soft gray-iron for the rest of the casting—at one time from two ladles. I never saw this practically demonstrated, and as this method has not been generally adopted it is safe to infer that it had some objections. * * * Chilled parts of iron present varying conditions in the fracture, some chilled surfaces being very abruptly defined, while others shoot off into the unchilled with a fine ragged and shading-off appearance. The latter is the best grade of chill—toughest—both in the chilled and unchilled portions.

Good cold blast charcoal iron is the best to produce chilled work; there is but little strictly cold blast charcoal iron made at the present time.

THE FOUNDRY

In a continuation of "Some Pencil Sketches of Failures," Henry Hansen illustrates some of the obstacles encountered in burning. The trend of the article may partly be gained from the following abstract:

The action of a stream of melted iron is a great deal like the action of other fluids; they have many properties in common. Have you ever observed the flow of a stream of water? Then you have noticed that the water at the sides flows a great deal slower than the central portion. You have seen that the water at the bottom also flows slower than the uppermost part. This is due to friction and melted iron is retarded in the same manner, only more so, for in addition to the friction caused by contact with the mold there is also produced a friction by the continued tendency of the metal to adhere, caused by it losing its fluidity. In passing through any channel the hottest part of the metal is continually in the central portion of the stream, and the velocity is proportionately greater here also. Thus it will be seen that the dullest metal flows over the very surface where we should have the hottest, and not only do we get the dullest metal here, but what is just as bad, where there should be the greatest velocity we find the least.

In an editorial on "Handicaps to Success" occurs this passage:

How many of our foundries are suffering from carrying the heavy load of overcapitalized stock of old tools? In how many instances would it prove a profitable venture to level them with the ground and make a fresh start? In how many are they waiting for present equipment to wear out before entering upon such a rearrangement as the present time calls for?

There is such a thing as making appliances last too long. Long life of some has been the death warrant of many a business. A thing is only economical so long as it performs the same amount of work with the same outlay as any other. When it ceases to do this, it is well to dispose of it to those who hanker after bargains in second-hand tools, or, failing in this, to give it away. It is money gained in the end.

"The Foundry Department of Girard College" is illustrated and described by M. F. Carr, who gives a fairly good chance to observe what has been accomplished in this institution.

S. S. Knight writes of "Sulphur in Iron," and treats on some of the peculiar results occasioned by the presence of this agent. The following is taken from Mr. Knight's article:

It has been authoritatively stated that less than .5 per cent of a per cent of sulphur would not be in the least detrimental to any iron. Many foundrymen have accepted this statement without the least investigation whatever, while others who have questioned it, remained passive. It may be here remarked that in reviewing foundry practices, it seems most wonderful that the processes of deductive reasoning, based upon the closest investigation, which have been so instrumental in advancing almost every other trade, have been basely underrated or absolutely igmored by the only persons who were in a position to obtain possession of the facts. In nearly every case superintendents and foremen have been willing to do as their predecessors had done, and not even make use of such suggestions as the very losses themselves thrust upon them. As an illustration of this, the author feels sure he will be pardoned if he cites an instance which he knows occurred in one of the larger foundries of the United States.

Losses were very high, yet good irons were used. Cupolas were heavily coked and fluxed with good stone, yet slag was retained by the metal. Large amounts of fuel were used and small amounts of blast and vice versa, still the difficulty could not be located. The castings were full of blow-holes and the metal often set while being poured into the mold in spite of excessive phosphorus. Limestone and metal were both carefully analyzed, but nothing of value noted. Iron which contained less than .035 of a per cent of sulphur before melting, when cast carried from .09 per cent to .1 per cent. Test bars stood less than 16,500 pounds tensile strain, and their deflection was lowered 10 per cent. Still this was not considered to be phenomenal since the only authority on the subject said that more than five times as much sulphur would not be detrimental to the metal. At last the suggestion was offered that the sulphur be cut down, but repeated trials could only partially effect this. The coke was at last analyzed and with this result:

Moisture, volatile matter and fixed carbon.....85.84 %
Ash .....14.16 %
Sulphur 2.170%

This coke was discarded and other used which contained less than .7 of a per cent of sulphur. The difficulties were obviated at once. Even chilled iron was now free from blow-holes and no iron carried over .06 of a per cent of sulphur. * * * Silicon in no known way tends to eliminate sulphur, and only the presence of phosphorus is known to give molten metal fluidity. As before stated, and as demonstrated above, even excessive quantities of both elements in no way qualified with certainty the detrimental action of sulphur. Only as the metal is kept free from such quantities as have been indicated is it safe for use.

In conclusion, the author gives as his belief what seems to him to be the greatest mistake of foundrymen to-day, namely: The confidence with which one element is played off against another in the mixing of irons for ordinary purposes. Because silicon, by means of graphite, renders the metal porous and open, while sulphur gives decreased fluidity, closeness of grain with

greatly augmented tendency to blow-holes, it should be distinctly understood that one element does not, in any part whatever, counteract or destroy the influence of the other. It is only as silicon acts upon carbon that density is diminished or porosity increased, and certain it is that neither of these results as produced by silicon exert but a very slight ameliorating influence over the harmful result of too large quantities of sulphur.

Several questions are answered in this issue in "Cast Iron Notes," by W. J. Keep. As tending to show how erratic conclusions may be formed by simply guessing at things, we reproduce one of these questions and Mr. Keep's answer thereto:

Some days ago I received a box containing several pieces of pig iron and the accompanying letter said: "This pig does not work entirely satisfactory to us, the casting is hard, very hard, and breaks and cracks when making fly or balance wheels with spokes. Now and then the rim will crack?"

Answer: It is a common experience to have the spokes crack when using iron containing from 1.50 to 2.00 per cent of silicon, which would be proper for such heavy castings. The cracking of the heavy rim is an opposite experience. I seldom say in print, but do sometimes in a personal letter, that a person who is engaged in foundry business should at least understand the nature of cast iron, and I advise the use of a test of shrinkage which is a mechanical analysis for silicon. If the silicon was anywhere near 2 per cent, the shrinkage of a half-square test bar one foot long would be about .165. If the arms of a fly wheel cracked and the shrinkage was .180 the silicon would be near 1.50 per cent. An increase of silicon so as to bring the shrinkage to .100 would probably prevent cracking. In making such heavy castings if the shrinkage is below .160, more scrap iron could be used. Any founder will do this much in the line of testing, if he realizes that he will often save more than his present profit amounts to.

The iron sent me in the box was a very good grade of silvery iron and should have cost several dollars a ton more than No. 3 pig, which it was probably purchased for. The broker or the furnace who sold it did not know what they were selling, and cer-

tainly if a founder should be fortunate enough to buy No. 3 and receive a silvery iron, he would lay it aside to use as he should need it, but a founder who does not know a good thing when he sees it will lose money and blame every one but himself.

Mr. George H. Ellis, chemist, at 116 Randolph street, Chicago, found that this pig iron contained 4.01 per cent silicon. By adding enough good scrap or No. 3 pig iron to bring the shrinkage down to .160, this silvery iron will be found to be a good softener.

The way to use silicon iron is to make a mixture of scrap and cheap pig iron, and if the shrinkage is not low enough add just a little silvery iron to soften it. Too much will produce spongy grain, and much over 3 per cent of silicon will produce brittle castings which will be hard.

THE INDUSTRIAL WORLD.

A contributor signing himself "Ferro" evidently believes that there is such a thing as going too far and makes some comments on shops which rely too much on technicalities. In his paper on "Chemistry in Foundry Practice," he lets out considerable truth that is too often hidden under a high sounding name. The following is the text:

"A little learning is a dangerous thing," is a saying which will apply very well to both the chemist and the foundryman. The former may have spent years in study of the theoretical effects of the different elements, and may be thoroughly conversant with their relations to each other, and the proportions in which they may combine; but when he comes to take his place in the foundry and has only a slight knowledge of the practical workings of the cupola or furnace, as the case may be, it becomes necessary for him to obtain an entirely new course of instruction in foundry practice, and is apt to fall into the mistaken idea that it can be attained in a year or less. Whereas it has cost the practical foundryman years of study and hard work to reach the same by watching the different rules of cause and effect. On the other hand, the foundryman, after having spent years successfully in

melting and mixing irons, upon acquiring a few theoretical ideas as to the effects of the different metalloids upon his mixture, is apt to fall into the very common error of overdoing the use of some one or more of them as a cure-all. He would have done better had he stuck to his old methods of constant watch of irons, changing the different brands as change became necessary.

There is no question as to the value of chemistry in the foundry, but the foundryman should have a knowledge of all the metalloids in his mixture, and should be able to make them up from the analysis given him by the chemist. Where such is the case, the chemist will find he has plenty to do, and will have earned his salary, at the same time his employer will have reaped the benefit. In this manner the foundryman and the chemist will go along hand in hand, working for a common end—successful mixtures.

In most cases to-day, the chemist, in coming out of school, university or college, and getting a situation in some institution where he may see iron charged and melted for probably a year, begins to look around for a position where he may attain greater honors, and also the necessary increase in salary. Having attained it, the first thing he is likely to do, is to criticize the manner in which the iron is charged, melted and handled, not knowing what great difference in methods are required for different lines of work. The result is, before long he is assuming the duties of the foundryman, causing dissension, and conveying the impression to the managers or superintendent that the chemist's modern ideas are being interfered with, and generally winds up in changes disagreeable to all parties concerned, and to the credit of neither.

Now on the part of the foundryman who has no knowledge of the effects of the different metalloids, he is very apt to have the idea that a "doctor" is not needed in his business, and begins by putting every straw he can in the way of the chemist. If the results are not obtained immediately, he is very quick to ridicule the ideas of the chemist, and forces him, as a matter of self-protection, to usurp the duties of the foundryman with the same general results spoken of above.

The writer favors chemistry in the foundry, but the chemist must assist the foundryman and the foundryman must obtain the necessary knowledge and assist the chemist, otherwise there will be failure to all concerned.

THE IRON AGE

In the face of repeated statements, telling us of the deterioration of molders, we are constantly being favored with examples of castings that show a marked improvement. An illustration of this is furnished in the Iron Age by some large helical gears made by the Geo. V. Cresson Co., of Philadelphia, of which that journal says:

All of the gearing was made on the improved gear molding machines of the Geo. V. Cresson Company, and the castings were practically perfect in all their dimensions. This accomplishment will appeal to the practical founder and engineer, also to those who understand the difficulties attending the casting of such large pieces. The pitch diameter of these wheels when cast was practically correct; for instance, the largest gear was 5 inches pitch and 154 4-10 inches pitch diameter, figured dimensions. The casting measured within a small fraction of these figures, and was true and round. The teeth of these gears are known as the "double helical," which form of tooth possesses great strength and works smoothly, without jar or noise. But in order to obtain these results the utmost care must be observed in the preparation of tooth blocks, as the teeth always have four points touching in the plane of their axis.

MACHINERY

An improved form of furnace for brass foundries is described in the January issue. A number of illustrations accompany this article, making the whole a timely contribution on the latest methods of building and operating brass furnaces. In speaking of fuel consumption, the writer says:

"The coal consumption varies with different conditions, draft, etc., and it seems strange that so few foundries make any provision for forced draft. Not that it is necessarily more economical at all times, but there are times when the natural draft is below its normal intensity and time as well as fuel, could probably be saved by the use of a blower. There is probably a certain rate of combustion at which each furnace will give best results,

and if a small blower was at hand to be used when needed, it would be possible to maintain the economical rate of combustion at all times.

"This subject is very little thought of, probably because the majority of brass foundries are small affairs, not running over three or four furnaces and about the same number of molders, so that the total cost does not assume very large proportions; still there is room for vast improvement in this department and it should be looked into by the economical manager."

John L. Klindwirth furnishes a paper on "Compressed Air for Hoisting Purposes," in which he says:

"As it seems likely that we shall soon have more business to look after, I wish to say a few things in regard to hoisting and lifting apparatus, for in this particular quite a number of improvements might be made. In visiting foundries, the one thing I have most often noticed is the inadequate provision made for lifting and handling light loads, up to say 4 or 5 tons, quickly and economically. Usually, one finds the slow hand crane, or the still slower chain block.

"Of course one can say nothing against their safety, or the fact that the pattern may be drawn with any desired speed from zero to the limit; but there are other means for doing this as well, much quicker and by far more economically, and this by means of the air-hoist. This, in the writer's opinion, is about the best way to handle varying loads.

"The only system that could approach this is, perhaps, the hydraulic system, but this possesses some undesirable features, such as leakage of valves and stuffing-boxes and freezing up, if precaution is not taken in draining pipes.

"Another point that may be mentioned in favor of the air-hoist and the necessary compressing plant, is the low cost of installation and flexibility of the system.

"The electric system, although suitable for traveling cranes and cranes of capacities over, say 5 tons, is not 'in it,' so to speak, when compared with the air-hoist for light loads. The efficiency is not nearly as high, the cost and maintenance considerably higher, the hoisting and lowering, slower. The steam crane need

hardly be mentioned, for it is becoming too well known as a profit-eater.

"The power-crane, when well made, does very well, still the cost of operation and the first cost, is greater than that of the air-hoist. Returning, now, to the points raised in favor of the air-hoist over hand-crane, the rapidity with which it works can be first considered. Taking a load of 2 tons, to be lifted by a hand-crane 3 feet and lowered again. This would require two men at the crank, and would occupy in ordinary working about five minutes. With the air-hoist one man could perform the same operation, with no exertion except pulling a chain, in at least one-third that time.

"This is quite an item, for usually one or more molders are delayed with their work by having to wait until their neighbor is done with the crane, which means additional expense (due to lost time) to the cost of casting.

"As regards the cost of hoisting by hand-crane and air-hoist, we will assume the case before mentioned. A load of 2 tons to be lifted 3 feet and then lowered. This would require two laborers at the cranks and one molder at the hook. Wages for 5 minutes, two laborers, $2\frac{1}{2}$ cents; molder, $2\frac{1}{4}$ cents$=4\frac{3}{4}$ cents. This, of course, does not take into consideration the time lost by one man leaving his work and resuming it again.

"For the air-hoist, operated by the molder and helper, assuming it would require but one-third the time necessary for the hand-crane, would amount to .4 cents for one laborer and .75 cents for molder, and air .05 cents; total of 1.2 cents or about one-quarter of that for hand-crane. Of course, it will not always require three men for the hand-crane, but neither will it always take two men for the air-hoist. Then, again, for heavier loads it may require from four to five men (who will have to leave their work) for the hand-crane, whereas two men are all that are needed for the air-hoist. To sum up, it can be readily shown that the air-hoist is much quicker in operation, which is, perhaps, the most important item—and further, that the cost of operation would be about one-third of that for hand-cranes.

"Coming to cost of installation; considering the cost of frame work for either kind of crane the same, it would cost about $100 to fit up a hand-crane, while an air-cylinder would cost about $75 at the outside. Of course a compressor, receiver, and pipes, would have to be bought, but these would not amount to more than $475.

"Assuming that we need three cranes, it would cost, at the least, $300 to put gearing, chain, hook, etc., on them. For the air-hoist it would be $225 and $475 for compressor and tank; total of $700, or $400 more than hand-cranes. This at 6 per cent interest, together with depreciation of compressor, etc., can be taken at $35 per year.

"This would be saved by air-hoists over hand-cranes after 1,000 lifts had been made. After that it would be simple gain, and one would have cranes of three times the capacity of the hand-cranes.

"As the compressor would probably compress air for six or more cranes (depending, of course, upon the number of lifts made in a given time), other uses could be found for the compressed air—such as hoisting metal to cupola, charging floor, or for a drop, sand-sifter, etc.

"To anyone desiring to put in the compressed air plant, a few notes in regard to it may be of interest. The most desirable compressor for a small plant is undoubtedly the one which is belt-driven from a line shaft. The belt is shifted on or off by an automatic device as the pressure in the receiver falls or rises. There are several firms making this style for from $300 to $400.

"The receiving tank should be about 3½ to 4 feet in diameter, by 8 feet high. A good-sized receiver is advantageous, in that the pressure will not fall so quickly should several hoists be lifting at once. The supply pipe should be connected to upper portion of the tank, as considerable water will gather in the bottom of tank, which must be drained off occasionally.

"The supply pipe may be 1¼ to 1½ inches diameter—this is ample. The precaution should be taken when putting up the pipe to make sure that no joints leak, for quite a large amount of air will escape in a day when under pressure of 80 lbs. per

square inch, and leaky joints are hard to find, for air does not show as steam does.

"There are a few points to mention in connection with the hoisting cylinders:

"The hook should not be a part of the piston rod, but should admit of being turned on it. Often it is desired to twist the load a little when suspended, and this cannot be done easily if the hook is part of the rod, for usually the friction of the piston prevents it. Of course, the chain may be twisted, but this is not desirable as it always tends to regain its original position.

"The best valve for operating hoist is undoubtedly the 3-way cock, for it admits of being opened very gradually, which is very desirable with air-hoists. The levers for each should be considerably longer than mostly made—about 9 inches long if circumstances permit.

"For best work the cylinders should have a very smooth bore; the smoother the surface the more satisfactory will be the results in hoisting. The thickness of metal in cylinders may be the same as for standard water-pipes.

"The size of pipe on cylinder should not be less than ½ inch diameter for a 19-inch cylinder, this gives speed enough. For smaller cylinders, pipes of smaller diameter may be used if desired."

IRON MOLDERS' JOURNAL.

"Tug" defines some of the qualities the foreman of a jobbing shop should possess in order that all things may proceed with as little friction as possible. After noting how specialty shops effect an increase in output, without increasing the labor or physical exertions of the individual shop employe, he says of specialty shops:

They are simply up-to-date. And I claim to-day that a molder can go into a specialty shop and make more money and not be as tired in mind and body as if he worked in a machinery shop. Why? Because the molder will go into the one shop knowing just what he has got to do, how long it is going to take him to do it, and at what time he will be home to his wife and

family at night; not so in a machinery shop. A molder gets there in the morning, shakes out his flasks, and cuts his sand, all the time wondering what he is going to do. Along comes the boss and says: "John, you will have to move over, Jim is going to make a column and he wants half your floor; take that pulley and make it eight inches deeper, put it in that old flask, if you nail a piece on it, it will do." By the time he gets the flask and the piece nailed on, facing sand mixed, and does more or less lifting about the shop, gets his pattern down and makes a start, the whistles blow. What is the result? He has to hustle in the afternoon, and does not properly secure his work and probably loses it. Whose fault is it? Nobody but the foreman's, I claim. It might be asked, how could it be remedied? My plan is this: Let every foreman in the machinery or jobbing shops show the molder the piece he will have to make next day, and where he has got to make it, and if two or more men are going to work on it, name them, and then put a sign up in the shop reading like this: "The blast will go on in this shop hereafter at 3:30, without fail." It can be done. What will be the result? The molder will go into that shop knowing what he is going to do, where he is going to do it, and best of all, what time he is going to get home. The manager of the shop will notice, too, that there is better work being turned out and perhaps more of it. These are some of the results that will follow the establishment of a good system.

J. T. A. gives a description of what causes a green sand mold to scab and how to prevent it, in which he says:

* * * When the molten iron enters the mold it generates, principally hydrogen gas, released by the application of the intense heat from the water in the sand. This gas has a tendency to come up rather than to go down, and in order to force it downwards to the coke bed or proper channel provided to carry it off, considerable pressure is necessary to begin with.

The pouring gate should be kept full and the risers hermetically sealed, and as the metal rises in the mold the pressure increases, thus forcing the gas down or out. If this gas is per-

mitted to come into the mold through its surfaces and thence through the iron, we have the scab, and perhaps, the blow-hole. The pressure mentioned will obviate this possibility, and in addition will also bear against the cope and prevent the sand that is dry and crumbling from falling into the mold, causing what is known as "draw down."

This additional pressure put upon the mold by keeping the risers closed will not injure any mold that is made properly.

THE TRADESMAN.

Many attempts have been made to employ metal cores in place of the ordinary sand cores, especially in places where great exactness has been desired. Some of these experiments have had considerable success, while others have been complete failures. Individual adaptability has much to do with this subject. The Tradesman, in taking up this matter, has this to say:

Iron cores, commonly called dies, are often used in order to harden the bearing surface, or to take the place of sand cores, as being more economical or more convenient. If the die has considerable taper there is generally not much difficulty in removing it from the casting, but if the taper be slight the difficulties are correspondingly increased.

I do not recommend the use of iron cores in making parallel holes. I am well aware of the fact that they have been much used, but an iron core never has the same shape when it leaves the casting that it had when it was placed in the mold. It grows larger at some point and changes shape each time it is used, until finally it becomes impossible to remove it without breaking the casting. However, for a tapered hole not requiring much nicety an iron core properly made and managed is just the thing. The chief objection to them lies in the difficulty of removing them from the casting.

Some people dip them in oil and then roll them in sharp (or parting) sand, as a means of preventing adhesion of the molten iron; others oil them and then apply silver lead or other blacking, but I advise you to just dip them in a bath of asphaltum and then bake it in the core oven. This is the easiest as well

as the most effective and satisfactory way that I have ever employed. Of course the consistency of the asphaltum modifies the quality of the work. You can make the coating thick or thin, as you please.

I am very particular to have my dies shaped just right and to have the prints on the pattern exactly correspond to the dies.

The lower end has the corners smoothly rounded so that there shall be no possible shaving of the sand when the die is set in the mold. The upper end is well tapered so that the cope print will be sure to guide it to the exact center.

A set of dies having the proper taper will last a long time. But so soon as the shape shall be materially changed new dies should be made.

To make these so as to require no finishing except on the emery wheel is a very easy matter if you proceed rightly. The impulse is to turn up such a pattern in one solid piece and to mold it in a vertical position. But this is entirely wrong. Not one workman in ten will make a mold true to the pattern in this position. The reasons are plain, if you only look for them carefully. The pattern stands up in the nowel without any support except at the lower end, and every time the rammer is struck into the sand it forces the pattern to lean in the opposite direction; and, since the pressure exerted by the rammer is not uniform throughout the full length of the pattern, the sand does not follow the receding pattern everywhere evenly. The result will be a casting out of round, or having a bunch on it somewhere. But clap two sticks together and turn them so that the pattern will be in halves (being sure to place the dowel pins before turning), and then, in molding, lay the half pattern on a smooth followboard. Thus molding horizontally, the sand will naturally lie snugly to the pattern everywhere and your dowels, both on the pattern and on the flask, fitting properly, you will produce a casting that will be almost absolutely perfect. It will cost something extra to make the pattern, but the extra cost stops right there, whereas if you make a cheap pattern, everything else connected with the job will be costly as long as you use it.

In discussing the advisability of operating a cupola without the use of flux, a writer in The Tradesman gives the following as his experience:

"The writer began melting without using flux; then used flour spar, and also limestone; then abandoned it all and denounced flux as useless. But for many years past he has used limestone flux, and he knows that it has been of very great value to him in his cupola practice. His former adverse decision upon it was simply the result of ignorance of the proper manner of using it. It may be that when all of our pig iron shall be furnished sand free we shall be able to do wholly without flux; but till then it is doubtful if the blast will suffice to supplant limestone."

The same journal says of apprenticeship:

"The real interests of capital and labor are, indeed, identical. Bankruptcies always increase as rapidly as wages diminish, and the profitable employment of general capital and labor is always simultaneous. The one class cannot wax while the other wanes, any more than a man can lift himself by his bootstraps. To either imagined phenomena is opposed inexorable law. The industrial history of the world through all the past thunders in our ears the fact that the employer and his workmen must stand or fall together. The smoke of the battle has cleared away so far that all may see that in order to maintain an adequate supply of competent workmen, some generally acceptable plan of education must be adopted. And by 'generally acceptable' I mean acceptable to the journeymen molders as well as to the employers. And, on the other hand, I mean acceptable to the employers as well as to the journeymen molders. 'You can lead a horse to water, but you cannot make him drink.'

"You can compel three molders to work in a shop with a dozen apprentices, but you cannot compel those molders to impart any great amount of instruction to the apprentices.

"Again, a group of molders may be able at some certain time to prevent their employer from having in his shop a fair proportion of apprentices, but 'it is a long lane that has no turn,' and

he will balance accounts with them sooner or later. All of which goes to show that in order to a satisfactory solution of the problem the general good must be the common object.

"We have read the letter of Martin Fox, president of the Iron Molders' Union of North America—a contribution to the general discussion of this subject, and surely if the molders generally shall be as candid and manly in their position on the topic as he has shown himself to be, the employers will have only themselves to blame if an equitable apprenticeship system shall not soon be an accomplished fact. But this would be too much to expect. There will be very marked differences of opinion, and there will also be very strong and very pestiferous opposition to any scheme, and that, too, without the slightest vestige of rational opinion to back it. This may be expected, and must be ignored.

"The American Foundrymen's Association is taking the initiative in this matter, and as this society is composed of men from all over the United States and Canada, it is probable that a system of apprenticeship that shall be reasonably acceptable to all sections and all interests will be elaborated. Furthermore, no system will be adopted without giving the molders an ample chance to take part in the matter.

"In order to a just system, concessions must be made by both parties to the compact. For instance, the molders must agree that no man shall be barred from learning the trade on account of age; and the employers must agree to a minimum age at which boys may be indentured that shall accord with the general opinion of the society on this point. The latter, because the little fellows need, must and shall have our protection. The former, because it is repugnant to common sense to deny any man the right to choose his vocation at any time of life."

THE RAILWAY AGE

In its issue of January 15th, describes the works of the Sargent Company, Chicago, and illustrates same with six photographic views of different departments.

Speaking of the "Apprentice Boy," the same journal observes:

"In general it may be said that the employing party should in

its own interest select only such apprentices as seem likely to appreciate the opportunities given them. This point settled, it is safe to say that it will be mutually advantageous to give him the fullest opportunity for instruction both in and out of working hours. He can then hardly fail to feel that his opportunity is a privilege to be cultivated to the utmost, with the result of a more valuable service during the period of his apprenticeship and the certainty of having a rightspirited and intelligent workman at its close."

THE RAILWAY REVIEW

In its issue of January 16th, has a very graphic description of the Standard Steel Works, of Philadelphia. Ten illustrations are given of the plant and some of its more noteworthy products.

THE MECHANICAL REVIEW.

Manchester, Eng.

That American foundrymen are becoming well known through the efforts of the different associations is seen from the following editorial in this journal on "Technical Education in the Foundry:"

"The letters on foundry practice which are now appearing in our correspondence columns may, we think, be said to indicate that foundry artisans are at last beginning to recognize the advantages which technical education has to offer—advantages which will be represented in a more substantial manner when employers awaken to the fact that intelligence in a foreman is a more important qualification than ability to drive the men in order to obtain the utmost possible amount of work out of them. We are sorry to have to confess that, generally speaking, this time is not yet, so far as our own country is concerned. We have no wish to harp on the ubiquitous theme of our inability to meet foreign competition, but it is well that we should keep in view the fact that a good deal of attention is given to the scientific side of iron-founding in France and Germany, while our American cousins have not only an abundance of literature on the subject, but also contrive to support in full vigor more than one technical society exclusively dealing with foundry matters. In face of these facts,

we must confess our disappointment at the indifference so very generally manifested in this country. Is it too much to hope that, as one of our correspondents suggested, the day may not be far distant when a British Foundrymen's Association will be established?"

To a question as to the effects of aluminium on iron and steel a correspondent in the same journal answers:

"Practical experience has shown that the addition of aluminium, pure or alloyed, in a suitable proportion, produces decidedly sounder castings both in iron and steel, the action being one of oxidation, as the oxygen in the carbonic oxides which would otherwise remain in the casting are removed by the aluminium. Owing to the great affinity which aluminium has for oxygen, a violent ebullition takes place in the mixing, which allows the gases to escape much more freely, and clears the metal in this way. Different steel makers have their ideas about using aluminium in the pure or alloyed state, and it is difficult to say which of the two is preferable. In the case, however, of cast iron, there is no doubt whatever that aluminium, in the form of an alloy with iron, produces a much better result in purifying cast iron and malleable castings than the pure aluminium. The purity of the commercial aluminium can now be guaranteed to within 1 per cent, and in the case of the aluminium alloy it is only necessary to ensure that a thorough mixing is effected with the iron, forming what is known as ferro-aluminium, and this can be done if proper care is exercised."